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ANALYSIS OF COOPERATIVE TRANSMISSION USING MODIFIED ROUTING PROTOCOL IN MANET WITH CHANNEL VARIATION

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ABSTRACT

In cooperative transmission relays can cooperate together and improve their performance and selection of protocols at the network layer that can increase the throughput, decreased the packet delay and also decrease end-to-end delay an transmission power. In this thesis, we study the joint problems of cooperative link and diversity in A Mobile Ad-Hoc Network (MANET) with variable wireless channels. In MANET the wireless nodes are in group and infrastructure less in nature. The major problems faced by wireless communication in real time environment are that of interference and un-reliable communication links. Much research work has been done to overcome this by using various techniques. Cooperative communication and transmission side diversity in the network are the two of the techniques that help in reducing interference and communication link failures. In this work, we propose a new type of protocol that proactively selects a group of forwarding nodes that work cooperatively forwarding the packet towards the destination.

We study the power allocation for decode-and-forward cooperative diversity protocol in a network. Multiple nodes are selected so as to co-ordinate their transmission to achieve transmission side diversity at the physical layer. In this network nodes are equipped with Omni-directional antenna to take the advantages of transmission side diversity to achieve energy saving under the assumption that channel gains are available at the transmitters.

The nodes are distributed uniformly, and to find the power allocation that minimizes the outage probability under a power constraint, where in the total power for all node power is less than a prescribed value during each two-stage transmission .In I stage fixed fraction of total power is allocated to the source, in II stage the remaining power is split equally among a set of selected nodes if the selected set is not empty, and otherwise is allocated to the source node.

We have also proposed a new technique to find the optimum route as a joint problem of the transmission power at the physical layer and the link selection at the network layer that incurs the minimum cost in terms of energy, no. of hops, available bandwidth and link quality (SNR), outage probability. Due to the computational and implementation complexity of the optimal solution, we derive the heuristic algorithms. We have done extensive simulation based on studies to verify the proposed techniques and with optimal schemes and heuristic methods, Analytical results show that our cooperative transmission schemes (OMCTSP) achieves average energy saving of more than 12% than direct transmission.

KEYWORDS: Cooperative Transmission, Manets, Variable Wireless Channel, Decode and Forward Protocol, Cooperative Diversity, Outage Probability, Throughput, OMCTSP

INTRODUCTION

A MANET is a multi-hop wireless network that is formed dynamically without infrastructure support. In this thesis we study the joint problems of energy efficient and diversity in wireless ad -hoc network. In wireless network the energy is spend by nodes on communication [1]. First Nodes are small in size and typically battery powered, inefficient

use of power causes network life time is decreased [2] [3]. So past several years most attention in energy efficient communication in ad hoc networks. The problem is approached in two different ways. At the network layer to find the energy efficient routes selection and at the physical layer energy efficient for wireless channel is called cooperative communication [4], [5]

1.1 Multi-Hop Relay Model

The propagation of electromagnetic signals through space, the energy required to establish a link between two nodes are proportional to distance between nodes which are in communication set is raised to fixed exponent is called path loss is assumed to be between 2 or 4.It is advantages in terms of energy saving through multi-hop routing in adhoc network. The multi-hop network extends coverage range figure 1 shows the multi-hop route between nodes

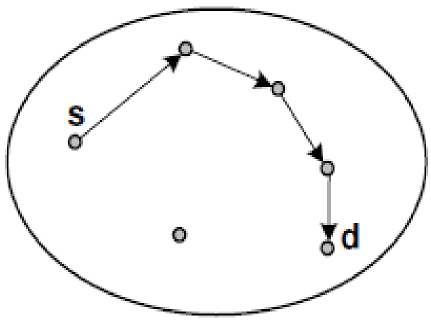

Figure 1: Multi-Hop Relaying Models

In this thesis we exploit the wireless broadcast property and take the advantages of transmission side diversity to achieve energy savings.

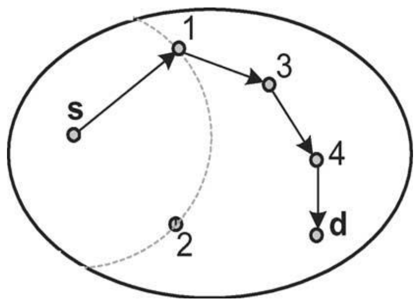

Figure 2: Wireless Broadcast Advantage

When omni directional antennas are used for communication, the signal transmitted by source node s is received by all nodes for example here is nodes are 1 and 2 within a certain radius is referred to as the wireless broadcast advantage (WBA)[6]. The problem of finding the minimum energy multicast and broadcast tree in a wireless network is studied in [2] and [3]. This problem is shown to be NP-Complete in [7] and [4]. In this dissertation we have assumed each node is equipped with single omni directional antennas allow many nodes can cooperate to each other is transmitting the information from source to other nodes and through this cooperation effect achieve same energy saving as multiple antenna As we refers as the wireless cooperation advantage (WCA) [8]

1.2 Cooperative Transmission

Our objective is to take advantage of the wireless broadcast property and the transmission side diversity through cooperation and in addition, consider the channel variation to find routes that reduce the end-to-end energy consumption, outage probability and some minimum end-to-end throughput. Take the simple example of cooperative transmission

Figure 1 exploits the broadcast nature of the wireless medium. An example of cooperative transmission of minimum energy path from node S to node D using dark line is given in Figure 2, in which we allow the last two predecessor nodes along the path for cooperative transmission to the next hop, i.e., hop = 2

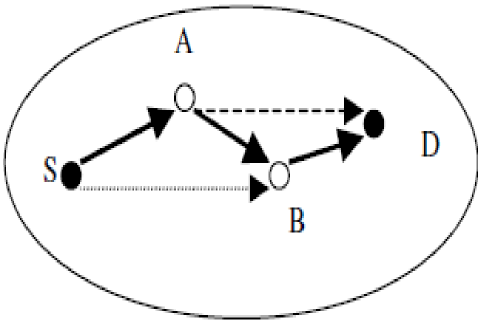

Figure 3: Cooperative Transmission

The following steps are for operation of cooperative transmission .In the first time slot source Node S transmits and is received by Node A in the second time slot B receives the signals transmitted co-operatively by node A and node S. Hence simultaneously multiple message received by one receiver from multiple transmitters are not considered collision but could be combined at the receiver to strengthen the signal, it requires new routing algorithms under the cooperative radio transmission model is called cooperative routing path [9] [10]

1.3 Cooperative Diversity

Second interesting property of wireless adhoc networks is diversity at the physical layer .The routing protocols point-to-point link and multi-hop link are used to transmit a signal from source node to destination node. Multi-hop link combines the transceiver transmission results that produce increasing SNR or decreasing SNR .SNR fluctuations occur across both frequency and time, also wireless channel variations called as fading, shadowing, and other forms of interference.

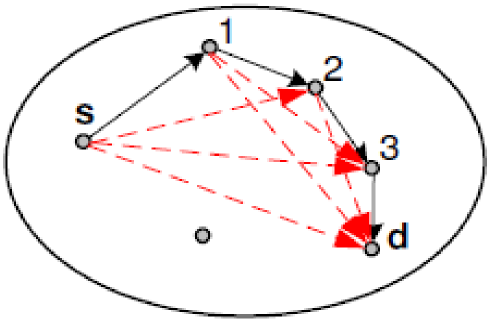

Figure 4: Cooperative Diversity

1.4 Infrastructure Less

MANET is a collection of wireless nodes that can exchange information without using any pre -existing fixed network infrastructure. It has most important application because in many contexts information exchange between mobile units cannot rely on any fixed network infrastructure, but on rapid configuration of a wireless connections on-the-fly. Mobile ad hoc network are independent wide area of research and allocations instead of cellular systems. As shown in below Figure 5

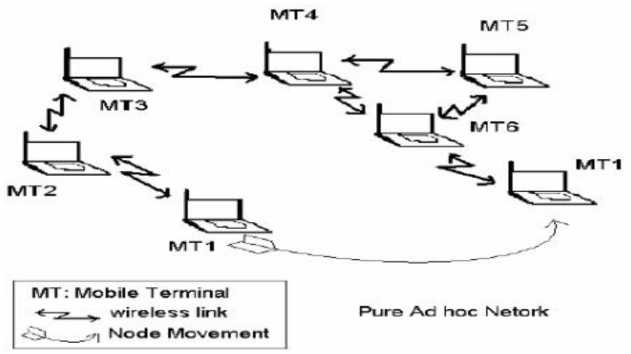

Figure 5: Mobile Ad Hoc Network Are Independent Wide Area of Research and Allocations Instead of Cellular Systems

Using diversity, the channel interference due to fading is reduced and increases the reliability of the wireless network[11],[12],[6] it can transfer same signal and receiver can detect these multiple copies of sent message correctly by using single Omni directional antenna with space diversity instead of multiple antennas which is costly and occupies more spaces. Then this new technique is known as cooperative diversity. An overview of different transmission diversity techniques is given in [13].the cooperative diversity is achieved by fully decodes and amplifies each information's. In addition to these, the algorithms is evaluate with repetition codes requires low complexity in the terminals by contrast space-time coded cooperative diversity requires more complexity in the terminals.

Our goal is to achieve energy saving through jointly cooperation and selection of energy routes with diversity. In order to achieve maximum energy saving by finding optimal route selection and shows probability of error is reduced. The existing literature Khandani et al. [14] they formulate the energy consumption in a static cooperative wireless network shows the maximum energy saving of 50% compare with non cooperative scheme, the energy savings achieved through cooperation, by using point to point scheme the heuristic algorithms to find energy efficient routes and also consider cooperative Multiple-Input Single-Output (MISO) technique for data transmission and energy savings can be achieved using cooperative routing techniques.

In this static network the transmitting nodes must know about channel state information hence nodes are cooperatively beam forming it requires synchronization [15] which is difficult in mobile adhoc network. Zhang et al. [16] extend Khandani's work to a multi-source multi-destination network. The power allocation that minimizes the outage probability with cooperative diversity system was derived in [17].

Our proposed cooperative transmission encode the information by using simple repetition code and detect at the receiver, the channel is fully characterized by the channel gain h. The channel gain capture the effects of a synchronism, multipath fading, shadowing and path-loss and it is inversely proportional to ${d_{ij}}^{\propto}$. It shows maximum saving of more than 12% by using proposed cooperative transmission than existing non cooperative transmission.

1.5 Summarization of Our Dissertation

We formulate the energy optimal cooperative routing between two nodes in fading environment subject to a constraint each node transmission power. We formula te the power allocation for a cooperative diversity with random location of nodes where only mean channel gain is available at the transmitters and are exponentially distribute. We develop optimal static routing algorithms to find minimum-energy routes in a network. We derive a Opportunistic cooperative routing as well as develop heuristic cooperative routing algorithms, and evaluate their performance using NS-2.32simulator.

2 System Requirements and Routing Models

The wireless network consisting of N devices are called nodes and it is distributed randomly in an area, where each node has a single omni directional antenna. We assume that each node can adjust its transmission power and that multiple nodes can coordinate their transmissions at the physical layer to form a cooperative link. So beam forming is not performed, only rough packet synchronization is required [16]. The data throughput, network reliability, link range is increases and reducing fading by using MIMO transmission. We model MIMO transmission as multiple MISO transmission [17]. Using MISO we formulate energy consumption in a cooperative MIMO transmission. Let N be the set of the nodes in the network N, and assume that there are $N = | N |$ nodes in the network.

2.1 Channel Model

We consider a time-slotted wireless channel between source and destination nodes, it is assumed to be fading channel is consist of pair of transmitting node ti receiving node rj and remaining nodes are serves as a relay nodes (i.e) N-2 nodes in a N nodes. The source transmits binary symbols. To minimize the effect of noise, fading and reduce the errors of received signal coding technique is used. Encoding of transmitted bits is done before being transmitted and then decoded at the encoder is using simple repetition code to encode the source output.

The decoder is using minimum Hamming distance to detect the transmitted signal. The noise at receiver is assumed to be complex, White Additive Noise with Gaussian distribution of zero mean and without loss of generality the power spectral density $P\eta_j$ is N0 .Binary modulation technique is used to modulate the code words.

The repetition code is used in a coding scheme that they added redundant bits are just a repetition of the original bits across the channel to achieve an error free communication. Repetition coding gets full diversity. Let we assume that the channel is fully characterized by the channel gain h_{ij}. The effects of symbol asynchronism, multipath fading, shadowing and path-loss are captured by channel gain and it is inversely proportional to $d_{ij}^{\propto}$

If **x** represents the k transmitted bits, then the output of the encoder **c** is given by [18]

$$c = xG \tag{2.1}$$

Where **G** represents the code generator matrix for simple repetition code of n bits, **G** is given by

$$\mathbf{G} = \left(\begin{array}{ccc|ccc} 1_{11} & \cdots & 0 & 1_{1n-k} & \cdots & 0 \\ \vdots & \ddots & \vdots & \vdots & \ddots & \vdots \\ 0 & \cdots & 1_{kk} & 0 & \cdots & 1_{kn} \end{array} \right) \tag{2.2}$$

Noting that for repetition code n=2

In this model cooperation at each stage has a collection of multiple-input single-output (MISO) links, where a set of transmitters T cooperatively send data to a set of receivers R. Let h_{ij}, h_{ik}, h_{kj} are channel gains between nodes $_{ij,\ ik}$ and $_{jk}$ and we assume that they are independent, exponentially distributed random variables with means $m_{i,j,}$ $m_{i,k}$ and $m_{k,j}$, respectively the receiver node will receive the signal in a two different phases which is transmitted by transmitting node.

Phase I: At first time slot the transmitting node i transmit with power $p_{s1,}$ and all other relay nodes and receiving node will listen[19],[20]. The transmitted signal xs_1 (t) and noise is η_j (t) received at r_j, it is assumed to be complex additive white Gaussian with power density P_{nj} .Then the received signal between i and j node is

$$y_{ij} = \sqrt{ps_1 \frac{hij}{d_{ij}^{\propto}}} * xs_1(t) + \eta_j(t) \tag{2.3}$$

Where h_{ij} is channel gain of i and j nodes, dij is distance between transmitting node i and receiving node j and $\propto$ s the path loss exponents. We assume a non line of sight has the Rayleigh distribution with unit power channel gain magnitude is $|hij|\ e^{j\theta ij}$ and θij is the phase.

Similarly the received signal at node k and noise is η_k (t) received at r_k.

$$y_{ik} = \sqrt{ps_1 \frac{hik}{d_{ik}^{\propto}}} * xs_1(t) + \eta_k(t) \tag{2.4}$$

If the received signal-to-noise ratio (SNR) exceeds a prescribed decoding threshold η, the received message can be decoded correctly. Let D denote the decoded set that includes all the nodes whose received message can be decoded properly.

Phase II: At second time slot the relay node k transmit signal $xs_2(t)$ to destination node j with power pj $\in$ D.p_{s2} is the power of source node in phase II, and noise is $\eta_j(t)$ received at r_j it is assumed to be complex additive white Gaussian with power density P_{nj}[19], [20]. .Then the received signal between k and j node is

$$y_{kj} = \sqrt{ps_2 \frac{hkj}{d_{kj}^{\propto}}} * xs_2(t) + \eta_j(t) \tag{2.5}$$

All the decoded nodes, as well as the source node, re-encode the message and transmit with the assigned power.

The original transmitted signal combines [21] both the signal received from source and the signal received from relay

$$Y_j = [y_{ij,}\ y_{kj}] \tag{2.6}$$

The total transmitted power is $P_T = Ps_1 + Ps_2$ and we have snr at receiver j ε R is

$$snr_{ij} = \frac{|h_{ij}|^2}{d_{ij}^{\propto}} * \frac{PT}{P\eta j} + \sum_{k \in D} p_k * h_{j,k} \tag{2.7}$$

2.2 Routing Model

A K-hop cooperative route l is a sequence of links 'k' is{ l_1……. l_k},where each link is formed between transmitting node T_k and receiving node r_k is $l_k = (t_k, r_k)$ using two stage cooperative transmission. Our objective is to find the route that minimize the end-to-end transmission power.

Definition 1 (Link Cost LC): The cost of link between transmitter t_k and receiver r_k is denoted by $LC(t_k, r_k)$ defined as the minimum power deliver the message from t_k to r_k using two stage cooperative transmission is subjected to throughputs, bandwidth, outage probability, no of hops.

The energy efficient routing can be formulated as follows

$$\text{Min} \sum_{lk \in l} LC(tk, rk) \tag{2.8}$$

2.1.1 Link Cost Formulation

Our objective is to determine power allocation for successful transmission from a set of transmitting nodes $S = \{s_1, s_2 \ldots s_n\}$ to a set of terminating nodes $T = \{t_1, t_2 \ldots t_m\}$.The link cost can be described in different forms are as follow

The Point-To-Point Link: It is a one-one communication between transmitter S= {s1} and terminator T = {t1} (i.e) n = 1, m=1 cost LC (s1, t1).For our simplification let us assume the channel gain is one and that the encoded in a signal has unit power and magnitude of the signal is multiplying a scaling factor w, Then the total transmitted power is w^2 is given by

$$LC(s1, t1) = \widetilde{PT} = \frac{SNRmin * p\eta j}{\alpha^2} \tag{2.9}$$

Point-to-Multipoint Link: In this case, n =1,m > 1, $S = \{s_1\}$, and $T = \{t_1, t_2, \ldots t_m\}$; m simultaneous SNR constraints must be satisfied at the receivers. The signal transmitted by the source node s_1 and it is received by all nodes within radius proportional to transmission power is called as broad cast link. Thus, the minimum power required for transmission LC (s1, T), is given by

$$LC(s, T) = \max \{LC(s1, t1), LC(s1, t2), \ldots LC(s1, tm)\} \tag{2.10}$$

Multipoint-to-Point Link: In this case, n > 1, m = 1, $S = \{s_1, s_2 \ldots s_n\}$, and T = {t1}. Here multiple nodes cooperate to transmit the same information to a single receiver node is called as cooperative link. Assume the channel gain is known at the transmitter, h_j is the vector of channel gains between transmitting nodes in T and a receiver $r_j \in R$ and vector w as the power scaling factor for nodes in T and dij as the distance between nodes I and j,h_{ij} is the channel gain between t_i and receive r_j.

In this case at the receiver the signals are add up, and complete decoding is possible as long as the received SNR is above the minimum threshold SNR_{min} for all nodes in R. Now let us consider the two vectors then the received signal at receiver r_j is

$$Y_j = \left(\frac{h_{ij}}{d_{ij}^{\alpha}}\right)^T * w + \eta j \tag{2.11}$$

$$\text{Where } w = \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ w_m \end{bmatrix} \frac{h_j}{d_{ij}^{\alpha}} = \begin{bmatrix} \frac{h_{1j}}{d_{1j}^{\alpha}} \\ \frac{h_{2j}}{d_{12}^{\alpha}} \\ . \\ . \\ \frac{h_{mj}}{d_{mj}^{\alpha}} \end{bmatrix}. \tag{2.12}$$

The following in equality should be satisfied for successful transmission the channel gain is above the threshold SNRmin

$$\left(\left(\frac{h_j}{d_{ij}^{\alpha}}\right)^T * w\right)^2 \geq SNRmin * P\eta j \text{ for all } r_j \in R \tag{2.13}$$

Where $P\eta j$ is the noise power at receiver r_j. The maximum transmitted power can be written as

$Wi^2 \leq P_T max$ for all $t_i \in T$ (2.14)

But our objective is successful transmission from transmitter to Receiver with minimizing power, the total transmitted power as

$$\|w\|^2 = \sum_{i=1}^{n} Wi^2 \quad (2.15)$$

And received signal power is

$$\left(\left(\frac{h_j}{d_{ij}^{\alpha}}\right)T * w\right)_2 \quad (2.16)$$

The power allocation problem is now an optimization problem with (m + n) constraints given by (2.12) and (2.14). **The optimal solution, however, may not exist as there may not be any feasible solution to the power allocation problem.**

2.1.2 Optimal Link Cost Formulation

The optimal solution is used to derive a solution which is in a closed form, it provides power allocation problem. Let as consider the set of receiver nodes that completely receive a information with zero outage be Super nodes. The channel gain is to compute between the transmitters and super node by using $h_{ij} = d_{ij}^{-\alpha}$

To solve power allocation problem, compute channel gains, consider a transmitter $t_i \in T$. ti has to transmit high power so that the total power from ti and other transmitters received at any node $r_j \in R$ is above the minimum SNR level and no information is received otherwise. For the receiver model the receiver with higher channel gain and nodes can decode the received signal successfully based on less transmit power. So approximate this by assuming all receivers $r_j \in R$ as equally bad in terms of transmit power requirement**.** Hence we assume that all receiver nodes $r_j \in R$ have smallest channel gain among all small channel gain h_{ij}'s. Therefore node r_j denote smallest channel gain

$$j^* = \arg_{r_j \in R} \min (h_{ij}/d_{ij}^{\alpha})^* \quad (2.17)$$

$(\mathbf{h_{ij} / d_{ij}^{\alpha}})^*$ is the channel gain to the super node when the transmit power is being computed. The channel gain vector between transmitters and the super node is denoted by $\left(\frac{h_{ij}^*}{d_{ij}^{\alpha}}\right)$, where the super node consists of nodes R = {r1; r2; : : : ; rn}. The i-th entry of the channel gain vector is given by

$$\left(\frac{h_{ij}^*}{d_{ij}^{\alpha}}\right) = \min_{r_j \in R} \frac{h_{ij}}{d_{ij}^{\alpha}} \quad (2.18)$$

And the resulting vector $\left(\frac{h_j}{d_j^{\alpha}}\right)^*$ is

$$\left(\frac{h_j}{d_{ij}^{\alpha}}\right)^* = \begin{bmatrix} min_{rj\in R}\frac{h_{1j}}{d_{1j}^{\alpha}} \\ min_{rj\in R}\frac{h_{2j}}{d_{2j}^{\alpha}} \\ min_{rj\in R}\frac{h_{3j}}{d_{3j}^{\alpha}} \\ \vdots \\ min_{rj\in R}\frac{h_{mj}}{d_{mj}^{\alpha}} \end{bmatrix} \tag{2.19}$$

The new optimization problem can rewritten by using $\left(\frac{h_j}{d_{ij}^{\alpha}}\right)^*$ is

$$\min_{ti\in T}\sum {w_i}^2 \tag{2 .20}$$

$$\text{w.r.t } w^T\left(\frac{h_j}{d_{ij}^{\alpha}}\right)^* \geq \sqrt{\text{SNRmin} * \text{p}\eta *} \tag{2.21}$$

$$\text{And } wi \leq \sqrt{\text{pmax}} \text{ for all } t_i \varepsilon T \tag{2.22}$$

$$\text{p}\eta * = \max_{rj\in R}\text{p}\eta\text{j} \tag{2.23}$$

Where $\text{p}\eta *$ denotes highest noise level of the super node will be able to decode the signal with no errors. The optimization problem can be solved by using the Lagrangian multiplier techniques .The resulting optimal allocation for each node i is given by

$$\widehat{wi} = \frac{\left(\frac{h_{ij}^*}{d_{ij}^{\alpha}}\right)}{\sum_{i=1}^{T}\left(\frac{h_j}{d_{ij}^{\alpha}}\right)*} \tag{2.24}$$

The resulting cooperative link cost LC(S, t_1), given by

$$\text{LC(s, t1)} = \sum_{ti\in T} w_i^2 = \frac{\text{SNRmin} * \text{p}\eta *}{\sum_{ti\in T}\left(\frac{h_{ij}^*}{d_{ij}^{\alpha}}\right)^2} \tag{2.25}$$

The above equation can be written in terms of the point-to-point link costs between all the source nodes and destination nodes, given by

$$\text{LC(s, t1)} = \frac{1}{\frac{SNRmin*p\eta*}{\left(\frac{h_{1j}^*}{d_{1j}^{\alpha}}\right)^2} + \frac{SNRmin*p\eta*}{\left(\frac{h_{2j}^*}{d_{2j}^{\alpha}}\right)^2} + \cdots\ldots + \frac{SNRmin*p\eta*}{\left(\frac{h_{mj}^*}{d_{mj}^{\alpha}}\right)^2}} \tag{2.26}$$

We can conclude that the transmitted signal is proportional to path loss attenuation therefore all nodes in the reliable set cooperate to send the information to a single receiver .Also the cooperative cost is smaller than each point-to-point cost. Hence it proves that always cooperative transmission saving more energy by taking the advantages of WCA.

3 Optimal Cooperative Routing

In this section, we develop optimal cooperative routing algorithms and thus find the least cost route from a source node s to a destination node d in an arbitrary wireless network. It is multi-hop in nature and selects a cooperative link in every time slot. Let T_k, R_k are the transmitting and receiving sets in every time slot k. Starting from the source node, the initial transmitting set, T0, is simply {s}, and a route is found as soon as the receiving set at some time-slot k contains the destination node d. Considering the transmitting and receiving sets in previous time-slots, the transmitting set in time slot k + 1 can be defined in three different ways.

3.1 Complexity of Cooperative Routing

In a network with n+1nodes, there are O (2n) nodes in the cooperation, a standard shortest path algorithm (such as the Dijkstra’s algorithm) will have complexity of O (22n). This indicates that finding the optimal cooperative route in an arbitrary network has exponential computational intricacy in the number of nodes, which becomes computationally difficult to manage for large networks. In the next subsection, we will develop suboptimal cooperative routing algorithms that have polynomial complexity and perform reasonably efficient compared with the optimal cooperative routing algorithm discussed here.

3.2 Suboptimal Cooperative Routing

In this section, we present two possible general suboptimal algorithms. The simulations are over a network generated by randomly placing nodes on a 150 × 150 and randomly choosing the source and destination nodes. The two proposed sub optimal algorithms were used to find cooperative path, The performance results obtained are the energy savings, end-to-end delay, packet delivery ratio, through put of the resulting cooperative strategy compare with respect to the optimal non cooperative path. The two suboptimal algorithms are analyzed as follows

3.2.1 Progressive Cooperative (Pc-3)

This is a MISO cooperative routing algorithm, where in every time-slot, the next node along the optimal non-cooperative route toward the destination is selected progressive cooperation PC-L: In this algorithm, the best path is selected after each transmission by using non cooperative shortest path Dijkstra's algorithm. It combines last three nodes into a single node because here L= 3 along with the source node ie super node [23]. The three nodes will be combined into single node under only when no of hopes are less and higher SNR value. This algorithm turns out to have a complexity of O (n3)[12] since the main loop is repeated O(n) times and each repetition has a complexity of O(n2)

3.2.2 Cooperation along Non- Cooperative Path (CAN-m)

In this suboptimal approach, first the optimal non- cooperative path is selected. In each cooperative path the last m predecessor nodes along the non-cooperative path cooperatively transmit to the next node on the path. For example in first step the source node transmits to node 1,and in second step combinedly the source node, node 1 transmit to node 2, in third step the source, node 1, and node 2 transmit to node 3. Finally, nodes 1, 2, and 3 transmit to the destination. Each hop in this protocol consists of cooperative transmission of the last m nodes on the path in order to send the packet to the next node. Hence in this class of algorithm needs to find the non cooperative route. So the complexity of this suboptimal scheme is same as the optimal non cooperative path in the network i.e., 0(n2) where n is the total number of nodes in the network .For our simplification we have taken the value of m = 3.

4 Cooperative Diversity

In wireless network individual channels experiences a unique fading effect, multiple channels can be used to compensate the error effect. Using diversity techniques we can reduce the error probability but cannot remove, it caused by combining several copies of same information over different channels is referred as fading. The fading channels are obtained by time, frequency, polarization, antenna. Different diversity methods have different combining methods.

4.1.1 Equal Ratio Combining

In this type of diversity combining technique, all the received signals are simply combined. Though this technique is the easiest one, it does not give satisfactory performance. The combined signal at the destination is denoted as

$$Y_j = [y_{ij}, y_{kj}] \; k,i = 1 \tag{4.1}$$

Where Y_j is the combined signal at the destination and $[y_{ij}, y_{kj}]$ where the signal from the source and the relay.

For our system model, the receiver node will receive the signal in a two different phases which is transmitted by transmitting node. At first time slot the transmitting node i and the received signal between i and j node is y_{ij} .Similarly the received signal at node k is y_{ik} .At second time slot the relay node k transmit to destination node j is y_{kj}.

4.1.2 Fixed Ratio Combiner

This technique gives much better performance than combining techniques. Here the incoming signals are weighted with a constant ratio instead of combining them. The ratio represents the average channel quality and does not consider influence of channel effects, consider only distance between stations .It can expresses as follows

$$y_j[n] = \sum (d_{k,j})^{\alpha} * y_{i,j}[n] \;_{kj} = 1 \tag{4.2}$$

Where $d_{k,j}$ represents weighting of the incoming signal $y_{k,j}$. Using one relay node,the above equation can be written by as follows

$$y_j[n] = (d_{i,j})^{\alpha} * y_{i,j}[n] + (d_{k,j})^{\alpha} * y_{k,j}[n] \tag{4.3}$$

4.1.3 Maximal Ratio Combiner

This Maximal ratio combining technique gives best performance by multiplying each input signal with its corresponding channel gain. For example

$$y_j = \Sigma \sqrt{ps_2 \frac{\mathrm{hkj}}{{d_{kj}}^{\propto}}} * xs_2(t) \; k,i = 1,2 \tag{4.4}$$

Where y_j is the combined signal at the destination for a system having one relay node, the above equation can be rewritten as

$$yd[n]=hs,d*[n]ys,d[n]+hr,d*[n]yr,d[n] \; .(2.29)$$

4.2 Outage Behavior

In this section, we are discussing the problem of route reliability in wireless networks. Our analysis starts at the reliability of non-cooperative communication and also how the reliability depends on the channel state and distance between the two nodes. Once we develop a result for non cooperative communication, we extend into cooperative communication network. In a network setting, we find the best path between source S and destination D for that we first define and analyze the reliability for fixed route and then our proposed algorithm. By taking the advantages of wireless

broadcast property the reliability is improved with the idea of diversity. The outage probability allows us for the decreased spectral efficiency

Required by half-duplex operation in the relays in the following

$$\gamma_s \triangleq P_s/N_0 \text{ and } \gamma_r \triangleq P_r/N_0 \tag{4.5}$$

4.2.1 Non-Cooperative Transmission

The mutual information as a function of the fading coefficients become a random variables

$$I_{NC} \leq \log\left(1 + \frac{\left|\frac{hij}{dij^{\alpha}}\right|^2 Ps}{No}\right) \tag{4.6}$$

The wireless link between the nodes i and j is h_{ij}/d_{ij}^{α} Where d_{ij} is the distance between nodes i and j,h_{ij} represents channel gain it captures the effect of channel fading, α is the path loss exponents between the range 2 and 4.

4.2.1.1 Outage Formulation

When the probability of error is 0 the channel is not in outage otherwise outage probability is 1

$$P_{Error} \approx P\ (\text{outage}) \tag{4.7}$$

The outage probability is then the probability that a mutual information falls below fixed rate R chosen a priori. The outage probability for rate R, in bits per channel use, is then given by Ozarow et al., 1994

$$P_{NC}out = \Pr\ [I_{NC} \leq R] = \Pr\left[\left|\frac{hij}{dij^{\alpha}}\right|^2 \leq \frac{2^R - 1}{(P_s/N0)}\right] \tag{4.8}$$

In [22] the outage probability is taken in a similar manner. If only limited number of n channel uses, the mutual information random variable is given by

$$I_{NC} = n \log\left(1 + 1/n \frac{\left|\frac{hij}{dij^{\alpha}}\right|^2 Ps}{No}\right) \tag{4.9}$$

Without lose of generality the outage probability is given by

$$P\ (\text{Outage}) = \Pr\left[\left|\frac{hij}{dij^{\alpha}}\right|^2 < \frac{2^R - 1}{(P_s/N0)}\right] \tag{4.10}$$

To simplify subsequent derivation, define the function for outage and success as follow;

$$1_{Outage} = \{1 \text{ if } \left|\frac{hij}{dij^{\alpha}}\right|^2 * (P_s/N0) < 1$$

$\{0$ else and

$$1_{Success} = 1 - 1_{Outage} \tag{4.11}$$

4.2.1.2 Capacity v_s Outage

The capacity-vs-Outage evaluate the tradeoff between a fixed rate and the achievable probability. for example a fixed rate R will support the rate, i.e, with

$$\text{Log}\left(1+\frac{\left|\frac{h_{ij}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}\right)\geq R \qquad (4.12)$$

The other channel will not support the rate i.e,

$$\text{Log}\left(1+\frac{\left|\frac{h_{ij}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}\right)< R \qquad (4.13)$$

It is referred as outage event and the maximum corresponding probability of the event is referred as Outage probability of the channel. The maximum rate with outage probability less than some threshold level called as capacity-vs-Outage

4.2.2 DF Relaying Protocol Capacity v_s Outage

For the simplest decode-and-forward algorithm with repetition coding, the mutual information random variable is

$$I_{SRDF}=\begin{cases}\frac{1}{2}\log\left(1+2\frac{\left|\frac{h_{ij}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}\right), if\ \frac{1}{2}\log\left(1+2\frac{\left|\frac{h_{ij}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}\right)\leq R\\ \frac{1}{2}\log\left(1+2\frac{\left|\frac{h_{ij}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}+2\frac{\left|\frac{h_{kj}}{d_{ij}^{\alpha}}\right|^{2}*Pr}{No}\right), if\ \frac{1}{2}\log\left(1+2\frac{\left|\frac{h_{kj}}{d_{ij}^{\alpha}}\right|^{2}*Ps}{No}\right)> R\end{cases} \qquad (4.14)$$

Let P_s is the transmission power to noise ratio for the source node and P_r is the transmission power to noise ratio for the relay node, then we have the outage between source and destination is given by

$$P_C^{out} = 1/2\ d_{ij}^{\alpha}\,(d_{ik}^{\alpha} + P_s/P_r\, d_{kj}^{\alpha})\ \frac{\left(2^{2R}-1\right)^{2}}{P_S^{2}} \qquad (4.15)$$

Assuming the assigned bandwidth is same for both source and relay nodes, outage probability (4.14) in terms of data rate, distances and transmission power can be further expressed as

$$P_C^{out} = 1/2\ d_{ij}^{\alpha}\,(d_{ik}^{\alpha} + P_s/P_r\, d_{kj}^{\alpha})\ \frac{\left(2^{2R}-1\right)^{2}\ *(NoRB)^{2}}{P_S^{2}} \qquad (4.16)$$

5 Opportunistic Cooperative Routing

In a static routing algorithm, route (a set of intermediate relays) is computed a priori and all messages are transmitted over same route only. At each intermediate relay, a unicast link is formed in a many-one manner. When a channels are variable this static routing is in efficient as it unicast. To overcome this problem the channels can be explored in broadcast manner to determine the best relay opportunistically after message has be broadcasted. An opportunistic routing algorithm any cast messages at intermediate nodes and select the next set of nodes that have successfully received. We refer to this set of receiver is referred as combined relay set. Let R (t_k) is the combined relay set for transmitter t_k.

Definition 2 (Opportunistic Route): Because of any casting, messages reach the destination through potentially different routes. An opportunistic route is the union of all possible routes between a source and a destination created by a choice of combined relays at each intermediate node.

In this section we are going to discuss about our proposed algorithm with reference to in [24], [25] which is without channel variation. We show that the proposed algorithm with channel variation will consume less energy as compared to existing algorithm Cooperative transmission Shortest Path Algorithms **(OMCTSP)** the routing protocol AODV is to be modified to implement the routing. In that every step of cooperative routing, all nodes can be overhearing when source nodes sending the route request pkt. After the transmission to the next node along the non-cooperative shortest path all the nodes that are not in outage, available Bandwidth, size of the packet, residual power available, number of hops will be added to the transmitting set for the next step of the routing. . Procedural for implementing our proposed algorithm is as follows

First modify the MAC layer protocol 802.11 to include SNR calculation. Next modify the routing protocol AODV to implement the routing algorithm proposed. We have selected AODV protocol because it consumes less enery [26]. Network is randomly distributed with defined no of nodes with specified initial energy.SNR value is estimated based on receiving power, distance, channel gain, noise power, and nodes that all decoded properly, while receiving the hello message and SNR value is stored in snr table. Unit variance model estimates expected value for channel gain for each slot index. Once the square of expected value is 1 then outage probability is estimated, when the mutual information as a function of the fading coefficients become a Random Variable. If the probability of error or Outage probability value is 0 then the channel is not in outage and outage probability value is 1 then the channel is in outage. Every node goes for calculating available bandwidth and also the number of hops for each path is calculated.

The source node when sending the route request packet will include outage probability, residual power available and available bandwidth, size of the packet. Intermediate nodes updates the link cost based on point to point connection, and push into request packet along with available bandwidth information. All the forwarding nodes will calculate SNR value of its received pkt, its available bandwidth, residual energy.

These values number of hops are also included in the route request pkt.[27],[28] When the destination node receives the route request packet, it selects the best path based on four parameters. Generate route reply message to source nod in the reverse path. Once a best path is selected, the destination node sends a route reply packet to the source node. This calculation goes on for all the packets forwarded towards the receiver. So that whenever the receiver finds a better path, it discards the old path and picks up the new path for data communication diversity techniques also going to add it shows more energy saving and it will reduces the outage probability also.

6 Performance Evaluation

In this subsection, we present our simulation result and compare the different algorithms in terms of average consumed power, Total consumed power throughput, SNR, Control Overhead, End- to-End Delay, Packet Delivery Ratio. We simulate a standard non cooperative routing algorithm as to measure power consumption achieved by cooperative routing algorithm. It is a basically a shortest path Dijkstra’s algorithm. In the stage 2 cooperative transmissions fails to deliver the message, we retransmit the message until the message is successfully delivered to the next hop. In our Mobile Ad hoc Network model nodes are uniformly distributed in a random manner. We select a source s and destination d nodes, and find the cooperative and non cooperative route from s to d. We then compute and compare the total consumed power using different routing algorithms

6.1 End-to-End Delay

The term end-to-end delay is defined us the time taken by a packet to be transmitted across a network from source node to destination node that includes all possible delays caused during route discovery latency, retransmission delays at

the MAC, propagation delay and transfer times. The protocol which shows higher end-to-end delay it means the performance of the protocol is bad due to network congestion.

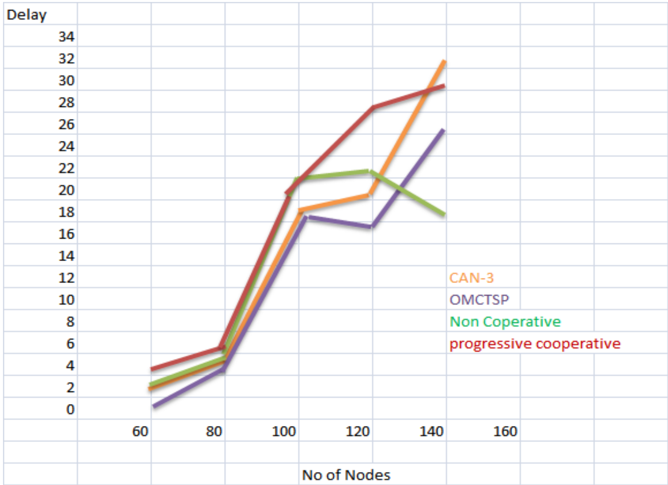

Figure 6: Shows End-to-End Delay vs No of Nodes for Three Different Cooperative Transmission with Existing Non Cooperative Transmission

The above figure shows the delay in the three different cooperative transmissions alone with the existing non cooperative transmission with the variation in the number of nodes .It is seen the delay in case of non cooperative is always more when compared with cooperative types. Between the three different cooperative type the delay is least always in our proposed OMCTSP algorithm.

6.2 Packet Delivery Ratio

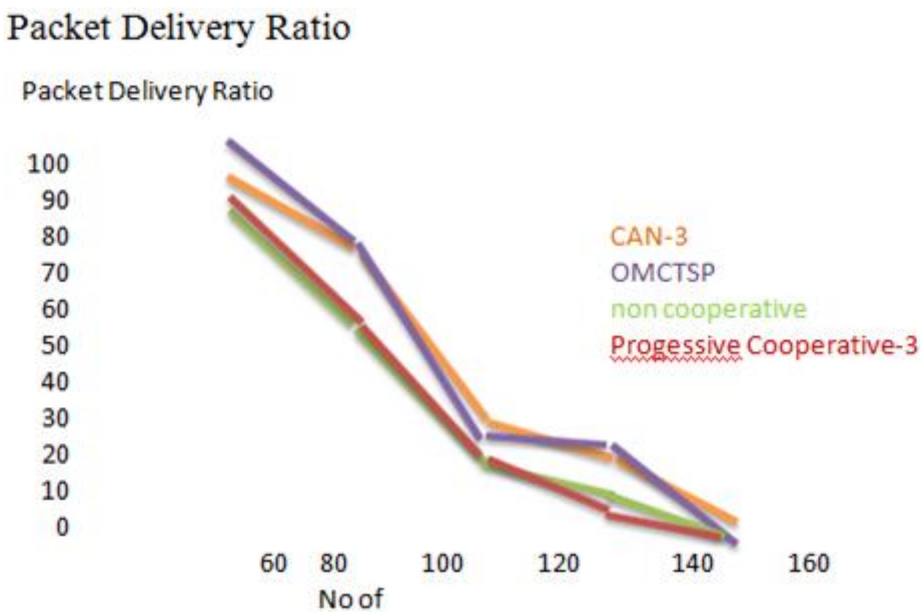

Figure 7: PDR vs Nodes for Cooperative Transmission Such as Can-3, OMCTSP, Progressive Cooperative-3 with Non Cooperative Transmission

Figure 7 shows the packet delivery ratio for cooperative algorithms proposed OMCTSP, PC-3 and CAN-3, and non-cooperative algorithm for various No of nodes. The proposed algorithm delivers 17% more than existing Non –cooperative algorithm, also compare with PC-3 15% more packet delivered and with approximately 10% more delivered.

6.3 Throughput

Throughput is referred to that, the ratio of the total amount of data that a receiver receives from a sender to a time it takes for receiver to get the last packet. A low delay in the network translates into higher throughput. Delay is one of the factors effecting throughput, other factors are routing overhead. Throughput gives the fraction of the channel capacity used for useful transmission and is one of the dimensional parameters of the network.

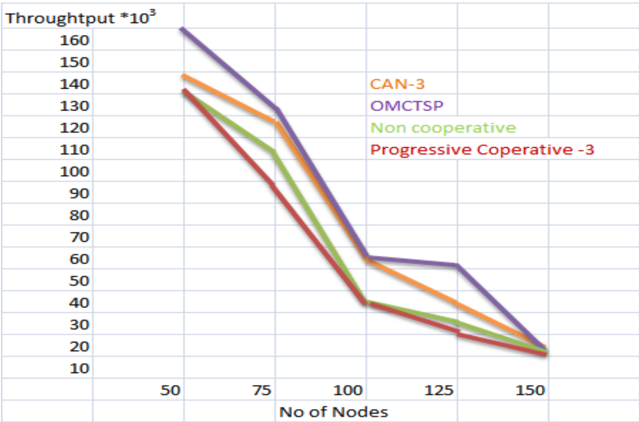

Figure 8: Throughput vs No of Nodes Comparison Output for ll Three Cooperative Transmission with Existing Non Cooperative Transmission

The Above Figure 6Shows the Throughputs for various nodes. The throughput in the our proposed scenario OMCTSP improves more than all other cooperative scenario and existing non - cooperative with the passage of time and the increase in node density. On comparison of the throughput for CAN-3 and Non Cooperative it is more in CAN.

6.4 Control Overhead

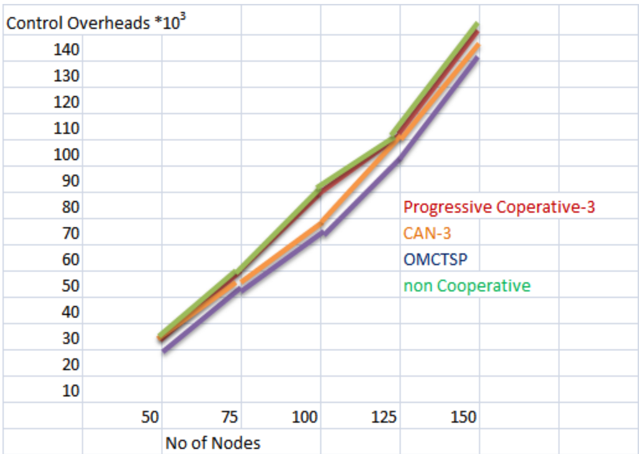

Figure 9: Control Overheads vs No of Nodes Output Comparison of Cooperative with Existing Non Cooperative Transmission

Figure 9 shows that control overhead for different nodes. Comparing Non –cooperative and PC-3 the control over head is similar. When comparing the proposed algorithm OMCTSP with CAN-3 the control overhead is more or less same, but on comparing with Non cooperative our OMCTSP is less.

6.5 Normalized Overhead

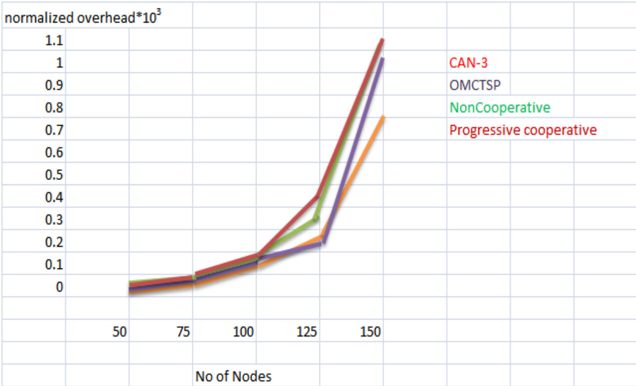

Figure 10: Shows Normalized Overhead Vs No of Nodes Output for Different Cooperative Transmission with Non Cooperative Scheme

The Normalized Overhead is higher in Existing Non cooperative algorithm when compare with CAN-3 and Proposed OMCTSP algorithm.

6.6 Average Consumed Energy

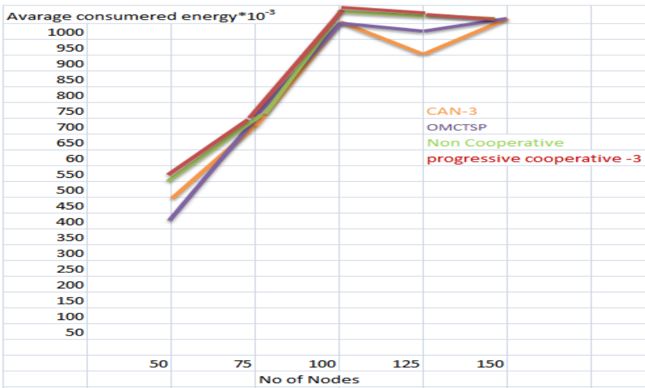

Figure 11: Average Consumed Energy vs Nodes

Figure 11 shows average consumed energy for cooperative algorithms PC-3, CAN-3, proposed OMCTSP and non-cooperative algorithm, for different number of nodes. Our proposed algorithm OMCTSP saves 30% of energy as compared Non-cooperative and also consumes 12% less energy than CAN-3.

Total Consumed Energy

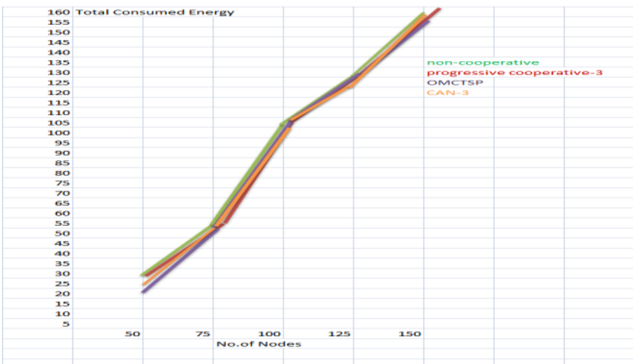

Figure 12: Total Consumed Energy

Figure 12 shows total consumed energy for different nodes of different cooperative algorithms like CAN-3, PC-3 and OMCTSP and Non cooperative scheme. When the number of nodes are more saving is comparatively less .whereas

when the number of nodes is less the total power consumed also reduces more in the proposed algorithm ie. Power saving is more for OMCTSP.

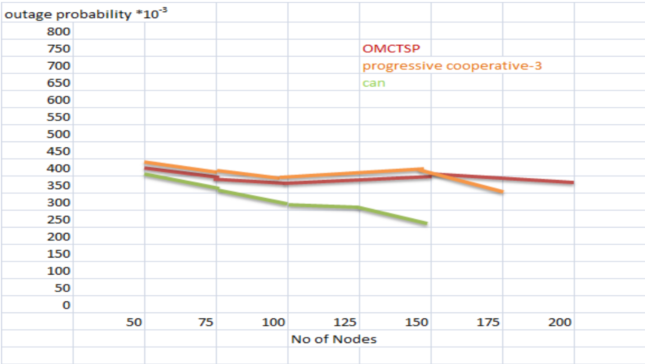

Figure 13

CONCULSIONS

We have studied the joint problems of cooperative link and diversity in A Mobile Ad-Hoc Network (MANET) with variable wireless channels. The wireless nodes are in group and infrastructure less in nature. We propose a new type of protocol that proactively selects a group of forwarding nodes that work cooperatively in forwarding the packet towards the destination.

We study the power allocation for decode-and-forward cooperative diversity protocol in a network. Multiple nodes are selected so as to co-ordinate their transmission to achieve transmission side diversity at the physical layer. We have also proposed a new technique to find the optimum route as a joint problem of the transmission power at the physical layer and the link selection at the network layer that incurs the minimum cost in terms of energy, no. of hops, available bandwidth and link quality (SNR), outage probability. We have done extensive simulation based on studies to verify the proposed techniques and with optimal schemes and heuristic methods, Analytical results show that our cooperative transmission schemes (OMCTSP) achieves average energy saving of more than 12% than direct transmission.

REFERENCES

1. L. M. Feeney and M. Nilsson, "Investigating the energy consumption of a wireless network interface in an ad hoc networking environment, "in Proc. INFOCOM 2001, Anchorage, AK, vol. 3, 2007, pp. 1548–1557.

2. J. H. Chang and L. Tassiulas, "Maximum lifetime routing in wireless sensor networks," IEEE/ACM Transactions on Networking, vol. 12August 2004.

3. C. K. Toh, "Maximum battery life routing to support ubiquitous mobile Computing in wireless ad hoc networks," IEEE Communications Magazine, 2001.

A. Nosratinia, T. Hunter, and A. Hedayat, "Cooperative communication in wireless networks," IEEE Communications Magazine, vol. 42, no. 10, pp. 74–80, Oct. 2004.

4. Scaglione, D. L. Goeckel, and J. N. Laneman, "Cooperative communications in mobile ad-hoc networks: Rethinking the link abstraction,"

5. J. E. Wieselthier, G. D. Nguyen, and A. Ephremides, "Algorithms for energy-efficient multicasting in ad hoc wireless networks," Mobile Netw. Appl., vol. 6, no. 3, pp. 251–263, Jun. 2001.

6. J. Laneman and G. Wornell, "Distributed space-time coded protocols for exploiting cooperative diversity in

wireless networks," IEEE Trans. Inform. Theory, vol. 49, no. 10, pp. 2415-2425, Oct. 2003.

7. T. Yung-Szu and G. J. Pottie, "Coherent cooperative transmission from multiple adjacent antennas to a distant stationary antenna through AWGN channels," in Proc. IEEE 55th Veh. Technol. Conf., 2002, vol. 1, pp. 130–134.
8. Fulu Li Kui Wu Andrew Lippman," Energy-Efficient Cooperative Routing in Multi-hop Wireless Ad Hoc Networks," Dept. of Computer Sci., The Media Laboratory MIT, Cambridge, MA USA
9. Khandani A., J. Abounadi, E. Modiano, L. Zheng, "Cooperative Routing in Wireless Networks," in the Proceeding of Allerton Conference 2003.
10. J. N. Laneman, D. N. Tse, and G. W. Wornell, "Cooperative diversity in wireless networks: Efficient protocols and outage behavior," IEEET rans. On Information Theory, vol. 50(12), Dec. 2004. IEEE Signal Processing Magazine, vol. 23, no. 5, pp. 15–19, Sep. 2006.
11. S. M. Alamouti, "A simple transmit diversity technique for wireless communications, "IEEE J. Sel. Areas Commun., vol. 16, no. 8, pp. 1451–1458, Oct. 1998.
12. R. T. Derryberry, S. D. Gray, D. M. Ionescu, G. Mandyam, and B. Raghothaman, "Transmit diversity in 3G CDMA systems," IEEECommun. Mag., vol. 40, no. 4, pp. 68–75, Apr. 2002

A. Khandani, J. Abounadi, E. Modiano, and L. Zheng, "Cooperative routing in static wireless networks," IEEE Transactions on Wireless Communications, vol. 55, No. 11, November 2007

13. IEEE 802.11 Working Group,http://www.manet.ieee.org/groups/802/11.
14. S. Wei, D. L. Goeckel, and M. C. Valenti, "Asynchronous cooperative diversity," IEEE Trans. Wireless Commun., vol. 5, no. 6, pp. 1547–1557, Jun. 2006.
15. Y. Lang, C. Bockelmann, D. Wubben, A. Dekorsy, and M. Sollner, "A novel resource allocation strategy for distributed MIMO multi-hop multi-commodity communications," in Proc. ITG Workshop on Smart Antennas, Vienna, Austria, Feb. 2008, pp. 125–132.
16. kamal khatir." Coded cooperative communications," thesis of Master of Science in Electrical Engineering Blekinge Institute of Technology Karlskrona, Sweden, September 2007.
17. J. Luo, R. S. Blum, L. J. Cimini, L. J. Greenstein, and A. M. Haimovich." Decode-and-Forward Cooperative Diversity with Power Allocation in Wireless Networks," IEEE Transactions On Wireless Communications, Vol. 6, NO. 3, March 2007 793.
18. J.N. Laneman, D.N.C. Tse, and G.W. Wornell. Cooperative diversity in wireless networks: efficient protocols and outage behavior. IEEE Transactionson Information Theory, 50(12):3062–3080, December 2004.
19. Mostafa Dehghany, Majid Ghaderiz and Dennis L. Goeckely. "Minimum-Energy Cooperative Routing in Wireless Networks with Channel Variations, "Department of Electrical and Computer Engineering, University of Massachusetts Amherst.
20. J.N. Laneman, Cooperative Diversity in Wireless Network; Algorithms and Architectures, "Ph.D. thesis Massachusetts Institute of Technology, Cambridge, MA, August 2002.
21. Maric and R. Yates, "Efficient multihop broadcast for wideband systems," al of Electronics and Comm IEEE J. Sel. Areas Commun., vol. 22, no. 6, pp. 1080–1088, Aug. 2004.

22. K. Vanisree and V.S.K. Reddy,' Analysis of modified cooperative transmission routing protocol in manet,' IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 2, No 3, March 2013

23. K. Vanisree and V.S.K. Reddy,' analysis of cooperative transmission modified routing protocol in manets. "International Journal of Applied Engineering and Technology 2012 Vol. 2 (4) October-December.

24. K. Vanisree and V.S.K. Reddy," Analysis of Non cooperative routing protocols in MANETS under Random Topology", Vol. 2, No, 2,J uly-Dec 2010

25. K. Vanisree and V.S.K. Reddy, "Efficient throughput analysis of non cooperative routing

26. K. Vanisree and V.S.K. Reddy. "energy saving in cooperative transmission using opportunistic protocol in MANET", IOSR Journal of and Communication Engineering (IOSR-ECE), e-ISSN: 2278-2834, vol 7, Issue 1, July-August 2013, PP